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Bean Tunnel

Drainage Design Summary Statement

Kent County Council

Document no: BRT-TG-XX-ZZ-TN-DD-0501

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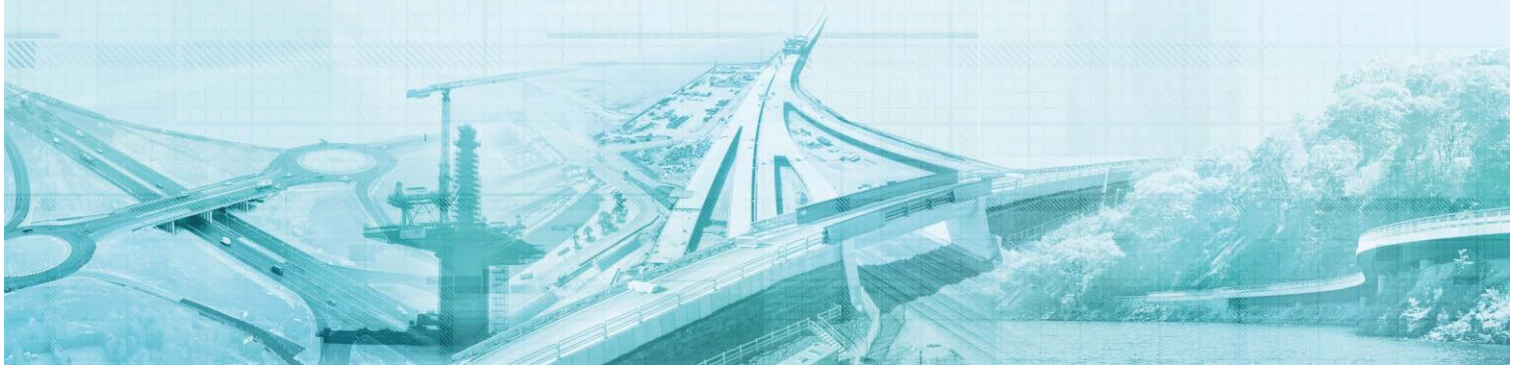

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1. Design Inputs

The Detailed Design was based on the drainage surveys carried out during the Preliminary Design phase. These were reviewed critically and the outputs of this exercise were collated on drawing BRT-TG-XX-ZZ-DR-HI-0510, to form the basis of the design.

No ground investigations and infiltration tests were carried out for the development of the drainage design. In line with Client's requirements, the proposed positive drainage network does not discharge to groundwater directly, but it out-falls into a lined lake forming part of the Bluewater water attenuation and treatment system.

2. Proposed Drainage Design

2.1. Previously developed site

The existing drainage networks serving Bluewater Parkway and Lime tree Avenue were retained in their layout and functionality. They will continue to provide three levels of treatment to the surface runoff:

- Gullies: trapping of silt and general floating rubbish
- Oil / Petrol Interceptors: trapping of oil / petrol spillages
- Reed Beds: final polishing elements to enhance water quality

The carparks runoff, currently discharging into reed bed 10, will be re-routed through the new reed bed (see paragraph 2.4). The proposed design doesn't modify this network upstream of the outfall.

2.2. New impermeable areas

In line with the Planning and Design and Access Statement (B2350500-JAC- REP-PLN-0001), the additional runoff generated by the new impermeable areas was considered negligible in comparison with the existing flows. Considering the systems of lakes around Bluewater as a whole, the additional flows will not overload the existing filtration and storage systems.

The new surface water drainage network and features were designed to satisfy the following criteria:

- 1 in 1 year return period – No surcharge of the drainage system;
- 1 in 30 year return period – No flooding of the drainage system;
- 1 in 100 year return period – Flooding is permitted, providing that overland flows are directed along the highway corridor to Sustainable Drainage Systems without affecting property.
- The network was checked for exceedance for flows up to and including the 1 in 100 year event +40% climate change.

The outputs from the calculations carried out to design the new network are included in Appendix A.

A series of gullies along the new link into the tunnel will pick up the surface water, route it to an existing oil interceptor and then to an existing drainage outfall into Lake No 4, feeding into the existing reed bed to the south of the new link. The new gullies along Bluewater Parkway will collect the runoff from the extended impermeable area. They are designed to minimise the need to trench across the carriageway and to reduce the impacts on the existing networks.

2.3. Tunnel

The vertical intersection point (high point) is located 20m to the East of the tunnel portal. To capture runoff from the Eastern Quarry site, two double gullies have been included in the design prepared by the Developer.

As such, there will be no surface water entering the tunnel except from the wheels of vehicles using the tunnel, and seepage of ground water into the tunnel is not anticipated. Therefore, there will be no surface water drainage provision within the tunnel, any water will simply run westwards into the Bluewater drainage system.

2.4. Reed Bed

The existing reed bed 10 will be demolished to make space for the access link into the tunnel. It is replaced by a new reed bed, located to the north of the access link, and designed to be the mirror image of the existing bed. This will ensure the level of treatment for the carpark's runoff is maintained.

Appendix A – Summary of Results

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

Return Period (years)	1	PIMP (%)	100
M5-60 (mm)	20.000	Add Flow / Climate Change (%)	0
Ratio R	0.429	Minimum Backdrop Height (m)	0.000
Maximum Rainfall (mm/hr)	150	Maximum Backdrop Height (m)	2.500
Maximum Time of Concentration (mins)	30	Min Design Depth for Optimisation (m)	1.200
Foul Sewage (l/s/ha)	0.000	Min Vel for Auto Design only (m/s)	0.75
Volumetric Runoff Coeff.	0.750	Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Simulation Criteria for Storm

Volumetric Runoff Coeff	0.750	Additional Flow - % of Total Flow	0.000
Areal Reduction Factor	1.000	MADD Factor * 10m³/ha Storage	2.000
Hot Start (mins)	0	Inlet Coeffiecient	0.800
Hot Start Level (mm)	0	Flow per Person per Day (l/per/day)	0.000
Manhole Headloss Coeff (Global)	0.500	Run Time (mins)	60
Foul Sewage per hectare (l/s)	0.000	Output Interval (mins)	1

Number of Input Hydrographs	0	Number of Storage Structures	0
Number of Online Controls	0	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	1	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.000	Storm Duration (mins)	30
Ratio R	0.429		

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1 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	0.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	2.000
Hot Start Level (mm)	0	Inlet Coeffiecient	0.800
Manhole Headloss Coeff (Global)	0.500	Flow per Person per Day (l/per/day)	0.000
Foul Sewage per hectare (l/s)	0.000		

Number of Input Hydrographs	0	Number of Storage Structures	0
Number of Online Controls	0	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	Ratio R	0.420
Region	England and Wales	Cv (Summer)	0.750
M5-60 (mm)	20.000	Cv (Winter)	0.840

Margin for Flood Risk Warning (mm)	300.0	DVD Status	OFF
Analysis Timestep	Fine	Inertia Status	OFF
DTS Status	ON		

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years)	1, 30, 100
Climate Change (%)	40, 40, 40

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.
P1-1.000	CH1-1.000	15 Winter	1	+40%	30/15 Summer			
P1-2.000	CH1-2.000	15 Winter	1	+40%	30/15 Summer			
P1-1.001	CH1-1.001	15 Winter	1	+40%	30/15 Summer			

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status
P1-1.000	CH1-1.000	5.667	-0.067	0.000	0.37			4.4	OK
P1-2.000	CH1-2.000	5.671	-0.069	0.000	0.46			5.9	OK
P1-1.001	CH1-1.001	5.651	-0.013	0.000	1.00			12.4	OK

PN	US/MH Name	Level Exceeded
P1-1.000	CH1-1.000	

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1 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Level Exceeded
P1-2.000	CH1-2.000	
P1-1.001	CH1-1.001	

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30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	0.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	2.000
Hot Start Level (mm)	0	Inlet Coeffiecient	0.800
Manhole Headloss Coeff (Global)	0.500	Flow per Person per Day (l/per/day)	0.000
Foul Sewage per hectare (l/s)	0.000		

Number of Input Hydrographs	0	Number of Storage Structures	0
Number of Online Controls	0	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model		FSR	Ratio R 0.420
Region	England and Wales	Cv (Summer)	0.750
M5-60 (mm)	20.000	Cv (Winter)	0.840

Margin for Flood Risk Warning (mm)	300.0	DVD Status	OFF
Analysis Timestep	Fine	Inertia Status	OFF
DTS Status	ON		

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years)	1, 30, 100
Climate Change (%)	40, 40, 40

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.
P1-1.000	CH1-1.000	15 Winter	30	+40%	30/15 Summer			
P1-2.000	CH1-2.000	15 Winter	30	+40%	30/15 Summer			
P1-1.001	CH1-1.001	15 Winter	30	+40%	30/15 Summer			

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status
P1-1.000	CH1-1.000	6.120	0.386	0.000	0.81			9.7	SURCHARGED
P1-2.000	CH1-2.000	6.144	0.404	0.000	1.00			12.8	SURCHARGED
P1-1.001	CH1-1.001	6.075	0.411	0.000	2.31			28.5	SURCHARGED

PN	US/MH Name	Level Exceeded
P1-1.000	CH1-1.000	

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30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Level Exceeded
P1-2.000	CH1-2.000	
P1-1.001	CH1-1.001	

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100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	0.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	2.000
Hot Start Level (mm)	0	Inlet Coeffiecient	0.800
Manhole Headloss Coeff (Global)	0.500	Flow per Person per Day (l/per/day)	0.000
Foul Sewage per hectare (l/s)	0.000		

Number of Input Hydrographs	0	Number of Storage Structures	0
Number of Online Controls	0	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model		FSR	Ratio R 0.420
Region	England and Wales	Cv (Summer)	0.750
M5-60 (mm)	20.000	Cv (Winter)	0.840

Margin for Flood Risk Warning (mm)	300.0	DVD Status	OFF
Analysis Timestep	Fine	Inertia Status	OFF
DTS Status	ON		

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years)	1, 30, 100
Climate Change (%)	40, 40, 40

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.
P1-1.000	CH1-1.000	15 Winter	100	+40%	30/15 Summer			
P1-2.000	CH1-2.000	15 Winter	100	+40%	30/15 Summer			
P1-1.001	CH1-1.001	15 Winter	100	+40%	30/15 Summer			

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status
P1-1.000	CH1-1.000	6.416	0.682	0.000	1.00			12.1	SURCHARGED
P1-2.000	CH1-2.000	6.455	0.715	0.000	1.26			16.0	SURCHARGED
P1-1.001	CH1-1.001	6.347	0.683	0.000	2.86			35.4	SURCHARGED

PN	US/MH Name	Level Exceeded
P1-1.000	CH1-1.000	

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100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Level Exceeded
P1-2.000	CH1-2.000	
P1-1.001	CH1-1.001	

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STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

Return Period (years)	1	PIMP (%)	100
M5-60 (mm)	20.000	Add Flow / Climate Change (%)	0
Ratio R	0.429	Minimum Backdrop Height (m)	0.000
Maximum Rainfall (mm/hr)	150	Maximum Backdrop Height (m)	2.500
Maximum Time of Concentration (mins)	30	Min Design Depth for Optimisation (m)	1.200
Foul Sewage (l/s/ha)	0.000	Min Vel for Auto Design only (m/s)	0.75
Volumetric Runoff Coeff.	0.750	Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Time Area Diagram for Storm

Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.051	4-8	0.019

Total Area Contributing (ha) = 0.070

Total Pipe Volume (m³) = 0.698

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Setting Out Information - True Coordinates (Storm)

PN	USMH Name	Dia/Len (mm)	Width (mm)	US Easting (m)	US Northing (m)	Intersection Easting (m)	Intersection Northing (m)	Layout (North)
P1-1.000	CH1-1.000	1200		558421.963	173507.038	558421.963	173507.038	
P1-2.000	CH1-2.000	1200		558434.102	173499.202	558434.102	173499.202	
P1-1.001	CH1-1.001	1200		558424.677	173494.858	558424.677	173494.858	

PN	DSMH Name	Dia/Len (mm)	Width (mm)	DS Easting (m)	DS Northing (m)	Layout (North)
P1-1.001	CH1-EXISTING	0		558408.448	173491.089	

Simulation Criteria for Storm

Volumetric Runoff Coeff	0.750	Additional Flow - % of Total Flow	0.000
Areal Reduction Factor	1.000	MADD Factor * 10m³/ha Storage	2.000
Hot Start (mins)	0	Inlet Coeffiecient	0.800
Hot Start Level (mm)	0	Flow per Person per Day (l/per/day)	0.000
Manhole Headloss Coeff (Global)	0.500	Run Time (mins)	60
Foul Sewage per hectare (l/s)	0.000	Output Interval (mins)	1

Number of Input Hydrographs	0	Number of Storage Structures	0
Number of Online Controls	0	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	1	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.000	Storm Duration (mins)	30
Ratio R	0.429		

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1 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	0.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	2.000
Hot Start Level (mm)	0	Inlet Coeffiecient	0.800
Manhole Headloss Coeff (Global)	0.500	Flow per Person per Day (l/per/day)	0.000
Foul Sewage per hectare (l/s)	0.000		

Number of Input Hydrographs	0	Number of Storage Structures	0
Number of Online Controls	0	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model		FSR	Ratio R 0.420
Region	England and Wales	Cv (Summer)	0.750
M5-60 (mm)	20.000	Cv (Winter)	0.840

Margin for Flood Risk Warning (mm)	300.0	DVD Status	OFF
Analysis Timestep	Fine	Inertia Status	OFF
DTS Status	ON		

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years)	1, 30, 100
Climate Change (%)	0, 0, 0

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.
P1-1.000	CH1-1.000	15 Winter	1	+0%	30/15 Summer			
P1-2.000	CH1-2.000	15 Winter	1	+0%	30/15 Summer			
P1-1.001	CH1-1.001	15 Winter	1	+0%	30/15 Summer			

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status
P1-1.000	CH1-1.000	5.639	-0.095	0.000	0.27			3.2	OK
P1-2.000	CH1-2.000	5.651	-0.089	0.000	0.34			4.3	OK
P1-1.001	CH1-1.001	5.613	-0.051	0.000	0.76			9.4	OK

PN	US/MH Name	Level Exceeded
P1-1.000	CH1-1.000	

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1 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Level Exceeded
P1-2.000	CH1-2.000	
P1-1.001	CH1-1.001	

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30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	0.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	2.000
Hot Start Level (mm)	0	Inlet Coeffiecient	0.800
Manhole Headloss Coeff (Global)	0.500	Flow per Person per Day (l/per/day)	0.000
Foul Sewage per hectare (l/s)	0.000		

Number of Input Hydrographs	0	Number of Storage Structures	0
Number of Online Controls	0	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model		FSR	Ratio R 0.420
Region	England and Wales	Cv (Summer)	0.750
M5-60 (mm)	20.000	Cv (Winter)	0.840

Margin for Flood Risk Warning (mm)	300.0	DVD Status	OFF
Analysis Timestep	Fine	Inertia Status	OFF
DTS Status	ON		

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years)	1, 30, 100
Climate Change (%)	0, 0, 0

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.
P1-1.000	CH1-1.000	15 Winter	30	+0%	30/15 Summer			
P1-2.000	CH1-2.000	15 Winter	30	+0%	30/15 Summer			
P1-1.001	CH1-1.001	15 Winter	30	+0%	30/15 Summer			

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status
P1-1.000	CH1-1.000	5.877	0.143	0.000	0.60			7.2	SURCHARGED
P1-2.000	CH1-2.000	5.888	0.148	0.000	0.74			9.4	SURCHARGED
P1-1.001	CH1-1.001	5.849	0.185	0.000	1.72			21.2	SURCHARGED

PN	US/MH Name	Level Exceeded
P1-1.000	CH1-1.000	

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30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Level Exceeded
P1-2.000	CH1-2.000	
P1-1.001	CH1-1.001	

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100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	0.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	2.000
Hot Start Level (mm)	0	Inlet Coeffiecient	0.800
Manhole Headloss Coeff (Global)	0.500	Flow per Person per Day (l/per/day)	0.000
Foul Sewage per hectare (l/s)	0.000		

Number of Input Hydrographs	0	Number of Storage Structures	0
Number of Online Controls	0	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model		FSR	Ratio R 0.420
Region	England and Wales	Cv (Summer)	0.750
M5-60 (mm)	20.000	Cv (Winter)	0.840

Margin for Flood Risk Warning (mm)	300.0	DVD Status	OFF
Analysis Timestep	Fine	Inertia Status	OFF
DTS Status	ON		

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years)	1, 30, 100
Climate Change (%)	0, 0, 0

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.
P1-1.000	CH1-1.000	15 Winter	100	+0%	30/15 Summer			
P1-2.000	CH1-2.000	15 Winter	100	+0%	30/15 Summer			
P1-1.001	CH1-1.001	15 Winter	100	+0%	30/15 Summer			

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status
P1-1.000	CH1-1.000	6.054	0.320	0.000	0.76			9.1	SURCHARGED
P1-2.000	CH1-2.000	6.075	0.335	0.000	0.94			11.9	SURCHARGED
P1-1.001	CH1-1.001	6.014	0.350	0.000	2.16			26.7	SURCHARGED

PN	US/MH Name	Level Exceeded
P1-1.000	CH1-1.000	

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100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Level Exceeded
P1-2.000	CH1-2.000	
P1-1.001	CH1-1.001	

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